The Examiner objected to the specification for informalities. The above amendments to the specification are believed to overcome the objections.

Objections to the Claims:

The Examiner objected to Claim 7 for informalities. Applicant has amended Claim 7 to overcome the objection. Applicant respectfully requests the Examiner to withdraw the objection to Claim 7.

Rejections under 35 U.S.C. § 112, 2nd ¶:

The Examiner rejected Claim 7 because of improper antecedent basis. Claim 7 has been amended to overcome the rejection. Applicant respectfully requests the Examiner to withdraw the rejection of Claim 7.

Claim Rejections

Claim 1 and dependent claims

The Examiner alleged that Claims 1, 5 and 6 are anticipated by Yamamura under 35 U.S.C. § 102(b). Without any admission that the Examiner's assertion is correct, Applicant has amended Claim 1 to expedite examination and allowance of the application.

Claim 1 has been amended so as to further define the function of the dual-purpose electrode: When a first (low) voltage is applied to the dual-purpose electrode, the first voltage causes an electrostatic potential, which collects electrons created in the substrate of a collection region. When a second (high) voltage is applied to the dual-purpose electrode, the charge collected in the collection region flows into a detection region. This means that charge storing and charge transfer are obtained by applying two different voltages to one and the same electrode. The electrode serves both as a confinement of the collected charge, and as a release element allowing the charge to flow to the detection region, as described in the present description, for example, at page 7, line 30 - page 8, line 19, page 9, lines 9 - 19, and page 9, line 31 - page 10, line 11.

Furthermore, Claim 1 has been amended to define "an active or passive pixel structure" instead of a "detector of electromagnetic radiation." For example, at page 6, line 8, the present description describes that the invention is applicable to any active or passive pixel structure.

Yamamura fails to disclose or suggest an active pixel or a passive pixel structure as defined in Claim 1. Instead, Yamamura discloses a CCD implementation of an imaging device. As shown in Yamamura's Figures 2, 5F, 6 and 7, two electrodes are used: a transfer control electrode 33 for controlling the transfer of charge accumulated in light receiving section 24 to vertical shift register section 25, and a forward electrode 34. As described at column 4, lines 10-55, the forward electrode 34 is supplied with a predetermined negative voltage to form a storage layer for the positive charges on the surface of the light receiving area 26. A positive voltage is applied to the transfer control electrode 33 so as to transfer the charges from the light receiving area to a shift register section 25. This means that two different electrodes are needed in the embodiments described in Yamamura, and that one electrode cannot perform the functions of first storing and afterwards transferring. This is contrary to the present invention in which one electrode performs these functions.

Therefore, Yamamura does not disclose each and every feature of the active or passive pixel structure defined in Claim 1 as amended. Applicant respectfully requests the Examiner to withdraw the rejection of Claim 1 and to pass Claim 1 to allowance. Claims 5 and 6 depend directly or indirectly from Claim 1 and further define the invention defined in Claim 1. Thus, for the reasons set forth above and because of the inventive features recited in Claims 5 and 6, Applicant respectfully submits that Claims 5 and 6 are patentably distinguished over Yamamura. Applicant respectfully requests the Examiner to withdraw the rejection of Claims 5 and 6 and to pass Claims 5 and 6 to allowance.

The Examiner alleged that Claims 1 and 4-6 are anticipated by Takemoto. Applicant respectfully submits that Claims 1 and 4-6 as amended each contain limitations that are not disclosed or suggested by Takemoto. For the reasons set forth hereinafter, Applicants respectfully submit that Claims 1 and 4-6 are not anticipated by Takemoto.

Takemoto discloses a passive pixel, but fails to disclose or suggest a dual-purpose electrode. The gate electrode 13 only serves to transfer charges from the pn-junction capacitance 18 to the diffused layer 14 by applying a positive pulse on the gate electrode 13. Takemoto does not disclose that two different voltages are applied to the gate electrode 13 with a purpose to store collect charges and transfer charges. Therefore, Takemoto does not disclose or suggest

each and every feature of Claim 1 as amended. Applicant respectfully requests the Examiner to withdraw the rejection of Claim 1 and to pass Claim 1 to allowance.

Claims 4-6 depend directly or indirectly from Claim 1 and further define the invention defined in Claim 1. Thus, for the reasons set forth above and because of the inventive features recited in Claims 4-6, Applicant respectfully submits that Claims 4-6 are patentably distinguished over Takemoto. Applicant respectfully requests the Examiner to withdraw the rejection of Claims 4–6 and to pass Claims 4–6 to allowance.

Claims 2, 3, 7 and 8

The Examiner alleges that Claims 2, 3, 7 and 8 are unpatentable over Takemoto as applied to Claims 1 and 4-6 in view of Kuroda under 35 U.S.C. § 103(a). For the reasons set forth hereinafter, Applicant respectfully disagrees with the Examiner's allegation.

As discussed above, Takemoto does not disclose or suggest a dual-purpose electrode as recited in Claim 1. Kuroda describes a CCD implementation of an imaging device, wherein the structure of the electrodes is as disclosed in Yamamura. Kuroda discloses a transfer electrode 6 and a transfer gate electrode 8. Thus, Kuroda does not disclose or suggest having one single electrode for charge storage and charge transfer.

Therefore, the alleged combination of Takemoto and Kuroda does not lead to the subject matter defined in Claim 1, namely a pixel structure for detecting electromagnetic radiation, comprising a dual-purpose electrode. Thus, Applicant respectfully submits that Claim 1 and dependent Claims 2, 3, 7 and 8 are non-obvious over a combination of Takemoto and Kuroda. Applicant respectfully requests the Examiner to withdraw the rejection of Claims 2, 3, 7 and 8 and to pass Claims 2, 3, 7 and 8 to allowance.

Claims 9-11

The Examiner alleges that claims 9-11 are unpatentable over Takemoto as applied to Claims 1 and 4-6 in view of Hook under 35 U.S.C. § 103(a). For the reasons set forth hereinafter, Applicant respectfully disagrees with the Examiner's allegation.

As discussed above, Takemoto does not disclose or suggest a dual-purpose electrode as recited in Claim 1. Hook discloses an active pixel comprising two electrodes 24 and 24'. Each of these electrodes is a single purpose electrode for transfer only: one for creating a transfer of

electron flow from the photosensitive device to a first active pixel sensor circuit, and one for creating a transfer of hole flow from the photosensitive device to a second active pixel sensor circuit. Thus, Hook does not disclose or suggest having a single electrode for charge storage and charge transfer.

Therefore, the alleged combination of Takemoto and Hook does not render the claimed pixel structure for detecting electromagnetic radiation comprising a dual-purpose electrode obvious. Thus, Applicant respectfully submits that Claim 1 and dependent Claims 6-11 are non-obvious over a combination of Takemoto and Hook. Applicant respectfully requests the Examiner to withdraw the rejection of Claims 6-11 and to pass Claims 6-11 to allowance.

CONCLUSION

Applicant has endeavored to address all of the Examiner's concerns as expressed in the outstanding Office Action. In light of the above remarks, reconsideration and withdrawal of the outstanding rejections is specifically requested.

Any claim amendments which are not specifically discussed in the above remarks are not made for patentability purposes and it is believed that the claims would satisfy the statutory requirements for patentability without entry of such amendments. If the Examiner finds any remaining impediment to the prompt allowance of these claims that could be clarified with a telephone conference, the Examiner is respectfully requested to initiate the same with the undersigned.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph starting at page 5, line 8 has been amended as follows:

In another embodiment, the surface regions of the semiconductor substrate beyond the collection region are barrier regions which have dopants of the first conductivity type at a concentration density larger than the concentration density of the semiconductor substrate, and the read-out ~~electronicsare~~ electronics are formed within shielding regions. Preferab~~e~~ly, at least part of the charge carriers that are generated in the semiconductor substrate underneath the shielding regions are collected by the collection region.

The paragraph starting at page 5, line 15 has been amended as follows:

In yet another embodiment, ~~the~~ a pinning region with dopants of the first conductivity type at a fourth concentration density is within the surface region. Preferably, the pinning region is not covered by the dual purpose electrode. In one embodiment, the pinning region is aligned with the dual-purpose electrode, and extends along the collection region.

The paragraph starting on page 7, line 19 has been amended as follows:

The shielding regions **42a, b** shield the photoelectrons created in the substrate **24** from the potential of any oxide regions or detection regions **26**. The electrostatic barrier formed at the interface between the shielding regions **42a, b** and the substrate **24** prevents charges generated underneath the ~~sheilding~~ shielding regions **42a, b** from diffusing into the junctions or other structures of the active pixel's additional electronics. There is no such electrostatic barrier present underneath the collection region **22**, so it can consequently gather charges that are generated under the other electronic components. The collection junction of the preferred embodiment has a near 100% fill factor, which means that nearly the whole surface of the pixel that is exposed to light contributes to the pixel's detected signal. Therefore, the photodiode can have a small junction area and a small capacitance, while having a large collecting volume.

The paragraph starting on page 8, line 20 has been amended as follows:

While complete charge transfer from the photodiode's collection region **22** of ~~f~~Fig. 2 to the detection region **26 of ~~f~~Fig. 2** is possible in theory, practically there are effects that may cause incomplete charge transfer: The complete transfer does not only depend on the voltage or voltage pulse applied to the gate 40, but also on the voltage present at the receiving node 26 in ~~f~~Fig. 2. Normally the V_{th} at the n doped side of the electrode is lower than at the p-dop~~e~~ed side. This effect also is a reason that an amount of charge is retained in the n-region after transfer. As the amount of retained charge is rather constant, it can be neglected in normal sensor operation. This effect is also counterac~~a~~ted by increasing the voltage at 26 and/or making the p-doped part of the electrode shorter: the resulting electric field will facilitate the transfer of electrons.

IN THE CLAIMS:

1. (Amended) ~~A detector of electromagnetic radiation~~ An active or passive pixel structure comprising:

a semiconductor substrate with dopants of a first conductivity type at a first concentration density, and with an insulating layer at its surface;

a collection region with dopants of a second conductivity type which is opposite the first conductivity type at a second concentration density, formed in the surface region of the semiconductor substrate;

a dual-purpose electrode formed on the insulating layer, extending over both the surface of at least part of the collection region and over at least part of the substrate, the dual-purpose electrode being intended to be driven by a first voltage for collecting in the collection region charges generated by electromagnetic radiation and by a second voltage for transferring the charges from the collection region into a detection region.

2. (Amended) The ~~detector~~ pixel structure recited in claim 1 wherein the substrate further comprises a barrier region of the first conductivity type with a concentration density of dopants being higher than the concentration density of dopants in the substrate

3. (Amended) The ~~detector~~ pixel structure recited in claim 2 wherein said barrier region is extending at least partly under the dual-purpose electrode.

4. (Amended) The ~~detector~~ pixel structure recited in claim 1 further comprising a detection region with dopants of the second conductivity type at a third concentration density,

formed in the surface region of the semiconductor substrate and not bordering the collection region and being connected to read-out electronics.

5. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 1, wherein the collection region forms a junction with the semiconductor substrate.

6. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 5, wherein the junction formed is a photodiode.

7. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 1, wherein the surface regions of the semiconductor substrate beyond the collection region are barrier regions which have dopants of the first conductivity type at a concentration density larger that the concentration density of the semiconductor substrate and ~~the~~ read-out ~~electronicsare~~ electronics are formed within ~~the~~ shielding regions.

8. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 7, wherein at least part of the charge carriers that are generated in the semiconductor substrate underneath the shielding regions are collected by the collection region.

9. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 1, wherein a pinning region with dopants of the first conductivity type at a fourth concentration density is within the surface region.

10. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 9, wherein the pinning region is not covered by the dual-purpose electrode.

11. (Amended) The ~~detector~~ pixel structure ~~described~~ recited in claim 10, wherein the pinning region is aligned with the dual-purpose electrode, and extends along the collection region.